THE M.I.T. TECHNICAL INFORMATION PROJECT
I. SYSTEM DESCRIPTION*

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ABSTRACT

A working model of a technical information system has been designed and constructed. The working literature is taken from twenty-one journals in the field of physics. The system utilizes remote consoles to access a time sharing computer facility (Project MAC). Programs have been developed for a large variety of search and processing techniques in real time as well as for delayed output. The system is intended to be a prototype operating in a realistic test environment.

November 2, 1964
S - 2

* Supported by a grant from the National Science Foundation and in part by Project MAC, an M.I.T. research program sponsored by the Advanced Research Projects Agency, Department of Defense, under Office of Naval Research Contract Number Nonr-4102(01). Reproduction in whole or in part is permitted for any purpose of the United States Government.

I. Introduction

The Technical Information Project at M.I.T. is an experiment in information system design. It is intended to provide a test bed facility to evaluate search strategies, to learn from direct experience what contributions modern technology can make in solving the problems of scientific exchange, and to localize those areas in the information process where technological improvements are most likely to succeed. The present paper describes the system. A subsequent report will discuss the experimental program, tests and operations.

Our experimental approach is to design a working, model-size information system to operate in the Boston-Cambridge area, capable of a wide spectrum of services in a realistic environment. In its present configuration, a user may sit at an electric typewriter, scan a stated range of literature and perform a search based on key words, key word in context, citation index, bibliographic coupling, author, location and various combinations of these. The response is printed back on the same typewriter within seconds of the request. The interaction between the user and the system is free of intermediaries and is accomplished by means of a language very close to natural English.

The system is available to broad classes of users and its operations are observed and monitored by means of test procedures and feed back. The information thus

obtained will guide the future evolution of the system by suggesting component and procedural incvations.

Several design requirements were imposed on the system to strengthen its prototype function. The strongest such requirement is that every component and process used must be evaluated not only in terms of its contribution to the model system but also in terms of its ability to be scaled upward by a factor of at least one hundred. This condition strongly affects the equipment and processing schemes that are admissable at this time. At one end we eliminate all human processing beyond the merest clerical manipulation on the grounds that expert judgement, evaluation, indexing, etc. require skills that are not ordinarily available in large numbers and are at any rate the very skills that one expects to conserve and release for other purposes. At the other extreme we eliminate for the time being schemes and processes that depend on computer manipulation of large bodies of text. Our system bases itself on a technological capability projected to about three years from now. The range of equipment capabilities at that time will not, in our judgement, include an appreciable capacity to either store or manipulate large bodies of text. If in the course of our work evidence to the contrary should appear, the question will be reconsidered.

What we presently call the system consists of five major components.

A. A sample literature

B. A computer facility

C. A library of programs

D. A population of users

E. A test and monitor procedure

Figure 1 is a block diagram of the system.

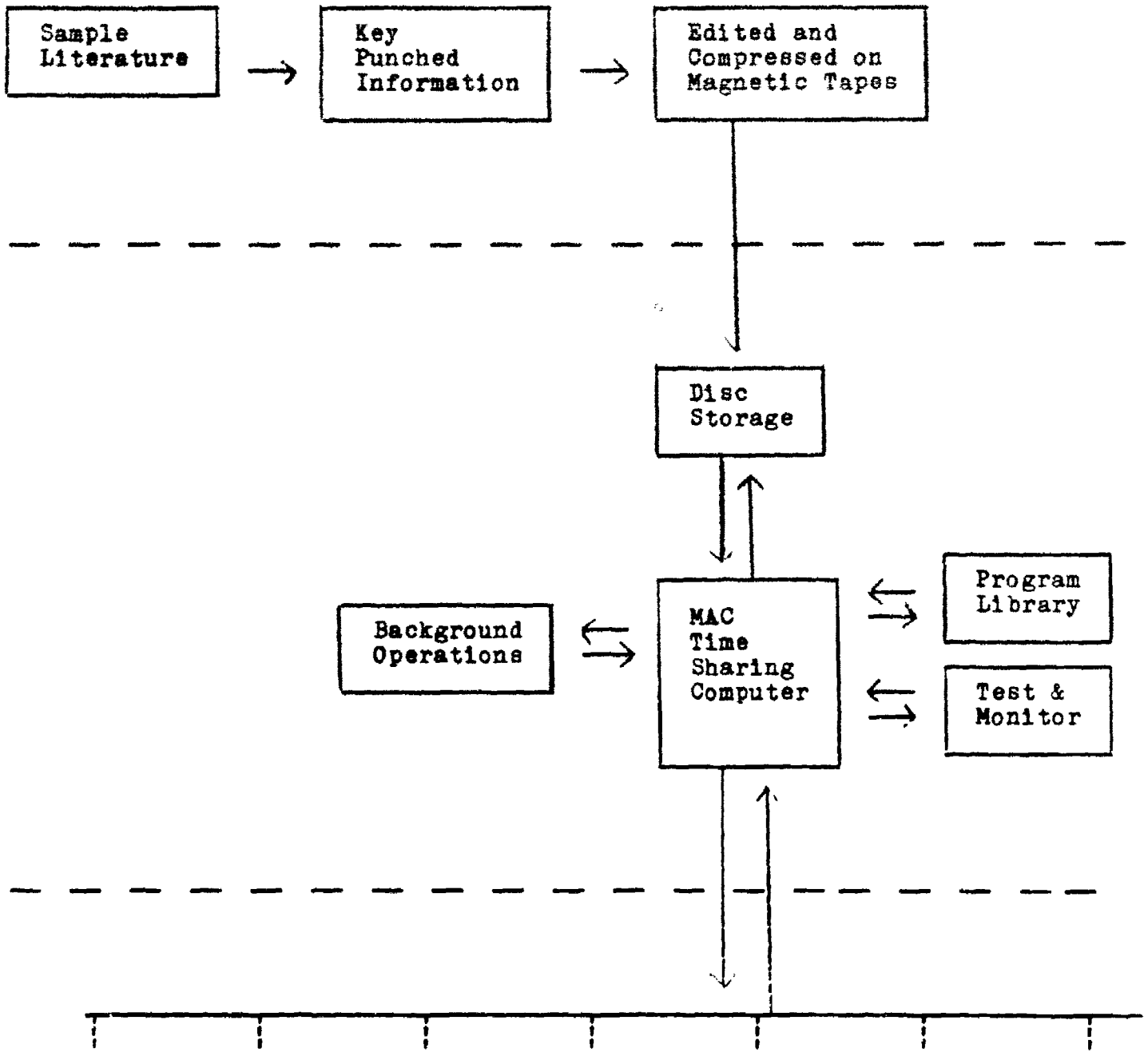
Elements of the incoming literature are key punched, edited, compressed, and transfered to magnetic tape. This tape is kept as a back up record. For actual processing purposes the material is transfered from tape to a permanent location on the computer disc where it is always available for use. The computer is a central facility accessed through one hundred remote teletype consoles that use it on a time sharing basis. Communication between console and computer is by ordinary telephone wire. It is virtually instantaneous and requires no special equipment at the user end. A library of programs is available to all users.

II The Sample Literature

The choice of a sample literature for a prototype information system is critical both with regard to size and distribution of material. The library in store must be above critical size in order to engage the serious interest of test users. It must be widely distributed among a large enough group of disciplines in order to avoid narrow specialization of users. On the other hand

FIGURE 1

FUNCTIONAL DIAGRAM OF THE MAC-TIP SYSTEM



it must have a certain cohesion and relatedness in order to stay within manageable experimental size. Our choice of journals to be included in the experimental system and the criteria for expansion are based on a statistical analysis of a larger number of citations in the physics literature. We consider a well edited journal to be an active carrier of information within the community of scientists. Each journal relates to a family of journals by refering to them and in turn serves as a source of references for others. There is a two way flow of information between any two journals which is a measure of their relatedness.

Let J_m (m = 0, 1, 2, 3, ...k) represent a list of journals and let J_{mn} be the percentage of references in journal m to journal n. We may construct a matrix of J_{mn}'s that shows the flow of information between the journals. We define a family of related journals in terms of the reference matrix in the following way: A journal matrix constitutes a related family if it has a strong upper left hand corner, a strong diagonal, a strong upper row, and if each column adds up to some predetermined percentage (our tentative choice is 50%). Such a family of journals usually consists of two member classes. One is a group of journals where J_{mn} is roughly equal to Jnm. That means there is strong two way communication within this class. A second class of journals exists where $J_{mn} \neq J_{nm}$. These are journals

that utilize the first group as sources of information but do not themselves contribute much to the reference literature. Figure 2 is an actual journal matrix that illustrates the family structure. J_0 to J_8 are members of the first class, J_9 to J_{14} are members of the second. Together J_0 to J_{14} constitute a family of related journals. J_{15} may be considered to be part of this family, it also is clearly the beginning of a new family of journals that extends to J_{19}. A full and quantitative discussion of the statistics of references may be found in our reports R-3 and R-4. [1,2]

The bulk of our present material is taken from the periodic physics literature. (See list below.)

List of Journals Processed for TIP

Annals of Physics

Applied Physics Letters

Canadian Journal of Physics

Helvetica Physica Acta

Japanese Journal of Applied Physics

Journal of Applied Physics

Journal of Chemical Physics

Journal of the Physical Society of Japan

Nuclear Physics

Nuovo Cimento

Physica

Physical Review

Physical Review Letters

Figure 2

REFERENCE MATRIX OF A FAMILY OF JOURNALS

	REFERENCES (FROM → / TO ↓)	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}	J_{17}	J_{18}	J_{19}
		Phys. Rev	Proc. Phys. Soc	Phys. Rev. Letters	J. Appl. Phys	Sov. Phys. – JETP	Physica	Nuovo Cimento	Zeit. Physik	Progr. Theor. Phys	Sov. Phys. – Sol. State	Can. J. Phys	Czech. J. Phys	Phys. Fluids	J. Phys. Soc. Japan	Proc. Roy. Soc.	J. Chem. Phys.	Can. J. Chem.	J. Chem. Phys.	J. Phys. Chem.	J. Am. Chem. Soc.
J_0	Phys. Rev.	47.2	34.1	29.9	14.5	18.5	15.3	25.0	19.7	21.5	12.9	16.1	12.3	8.7	15.4	6.9	12.3			1.3	
J_1	Proc. Phys. Soc.	2.0	9.4	1.2	2.4		4.3	1.0	2.5	1.1	1.2	2.0	2.0		3.7	2.9					
J_2	Phys. Rev. Letters	12.0	1.6	21.5	1.9	2.5	1.7	14.4	4.3	13.7		2.6	1.0	2.0							
J_3	J. Appl. Phys	1.3	2.4	1.8	23.0						2.1	1.4	3.5	3.4	2.6	1.0					
J_4	Sov. Phys. – JETP	2.5		2.0	1.3	32.0		3.0	2.2	1.1	9.3		2.5			1.0					
J_5	Physica	1.1					21.5			1.7		2.0	1.5	1.2	2.2	1.3					
J_6	Nuovo Cimento	4.0	1.0	4.5		3.1		21.4		5.4			2.0		1.6						
J_7	Zeit. Physik		3.1				3.0		20.4		1.0		2.5			1.9					
J_8	Progr. Theor. Phys.	1.5						5.7		25.7											
J_9	Sov. Phys. – Sol. State										23.5		1.5								
J_{10}	Can. J. Phys.											9.1									
J_{11}	Czech. J. Phys.												12.5								
J_{12}	Phys. Fluids													19.5							
J_{13}	J. Phys. Soc. Japan												1.0		10.2						
J_{14}	Proc. Roy. Soc.	1.5	6.2	1.1	2.7		4.5	1.7	2.5	2.0	1.0	4.5	4.0	3.5		14.7	3.3	1.1	1.2	2.1	
J_{15}	J. Chem. Phys.		3.1	1.1	2.1		5.0					2.1	3.0	13.1	5.4	6.5	33.9	5.4	1.1	7.7	5.4
J_{16}	Can. J. Chem.																	12.3	1.3	1.1	
J_{17}	J. Chem. Eng. Data															2.7		10.2	25.4	3.7	5.0
J_{18}	J. Phys. Chem.															1.3	1.4	3.0		12.9	1.4
J_{19}	J. Am. Chem. Soc.						2.0									3.5	6.5	17.6	19.4	22.3	5.3

Physics Letters

Proceedings of the Physical Society (London)

Progress of Theoretical Physics (Kyoto)

Soviet Physics - JETP

Soviet Physics - Solid State

Soviet Physics - Technical Physics

The Physics of Fluids

The choice of journals is based on the family matrix generated by the Physical Review as J_{00}. Twenty one journals are being processed on a continuing basis of up-dating. Of these, the Physical Review extends back to Volume 77, 1950; the Journal of Chemical Physics and Physical Review Letters extend back to 1958; 12 other journals were started in 1963 and 6 in 1964. The sixteen years of Physical Review provide a historical record of significant extent, the other journals are taken from a variety of lands and cultures.

For each of the articles in each of the above journals we record the location of the article (journal, volume, page), the title, authors, the institutional affiliation of the authors, the citations (journal, volume, page), the location of the article in Physics Abstracts (when this information becomes available), and subject index information if the latter is available from a published source. The above information is punched on cards, verified, edited, and transfered to magnetic tape for permanent storage. This tape is then edited by the computer to detect clerical errors and transferred to an assigned location on the computer disc memory where it is immediately available for manipulation or

search. Daily and weekly monitoring programs have been devised that test the integrity of the data. If any fault is detected it can be localized and repaired from any of the back up tapes that are kept for that purpose.

At present our library consists of 25,000 articles growing at the rate of some 1500 per month. The monthly additions to our information store comprise about 50-60% of all papers abstracted in Physics Abstracts.

III The Computer Facility

The computer facility at our disposal is the IBM 7094 operating in remote, time sharing fashion. This facility is itself an experimental project (Project MAC). It consists of a central computer with 100 remote consoles having access to its facilities. The consoles are standard teletype machines presently distributed at various locations around the M.I.T. campus. Contact with the computer is by means of ordinary telephone connection. The 100 consoles are available to perhaps 400 people who can at any time try to use the computer on a time sharing basis. As many as thirty people may use the computer at the same time. Those interested in a more detailed understanding of the M.I.T. time sharing computer system may consult the Compatible Time Sharing System (CTSS) Manual (3). As a general statement of purpose and capability we quote the following paragraphs from the introduction to the CTSS manual.

"The motivation for time-shared computer usage arises

out of the slow man-computer interaction rate presently possible with the bigger, more advanced computers. This rate has changed little (and has become worse in some cases) in the last decade of widespread computer use.

"In part, this effect has been due to the fact that as elementary problems become mastered on the computer, more complex problems immediately become of interest. As a result, larger and more complicated programs are written to take advantage of larger and faster computers. Even if a typewriter is the console, there are usually lacking the sophisticated query and response programs which are vitally necessary to allow effective interaction between the programmer and the computer without large economic loss and also to make each interaction more meaningful by extensive and complex system programming to assist in the man-computer communication.

"In addition to allowing the development of usable and sophisticated debugging techniques, an efficient time-sharing system should make feasible a number of relatively new computer applications which can be implemented only at great cost in a conventional system. Any problem requiring a high degree of intermixture of computation and communication on a real-time basis should readily lend itself to time-sharing techniques. Examples of this type of application include: decision-tree problems; real-time management problems; gaming problems; sociological experiments; teaching machines; language learning problems; library retrieval; text editing;

algebra manipulators; and many more.

"The Compatible Time-Sharing System (CTSS) is a general-purpose programming system which allows a new form of computer operation to evolve and yet allows most older pre-time-sharing programming systems to continue to be operated. CTSS is used at a console which may be of several varieties, but which in essence is an electric typewriter. Each console user controls the computer (i.e. as seen by him) by issuing standard commands, one at a time. The commands allow convenient performance of most of the routine programming operations such as input, translation, loading, execution, stopping and inspection of programs. This command convenience, although it has a fixed format, is with no loss of generality since a command can also be used to start an arbitrary programming subsystem with its own control language level."

IV The Programs

The computer operates on the literature by means of a set of programed commands. The program language and format is the interface between the user and the literature on which the computer operates. It is in a way the only aspect of the computer that a user need be aware of. As such it is the very heart of the system and most sensitive to human needs. One must make the distinction between what is called the programming language and the language of engagement between man and machine. The programming language is a set of instructions to the computer written in the particular

and esoteric vernacular that matches computer capabilities. It is largely incomprehensible when regarded as English text. Such language may be FORTRAN, MAD, FAP, etc. The language that a user would comfortably wish to use when performing a literature search should be as close as possible to natural English and should have a sufficient vocabulary of verbs and nouns to allow a flexable group of choices to be made by the user without requiring the intermediary of a programing expert. In our case the programing language is largely FAP and need not concern us here. The language of engagement has evolved through several generations of use and is constantly being changed and adjusted in response to user feed back.

The literature and program facilities are available to all MAC system users. Indeed, the facilities are theoretically available to any person in the world who has access to Bell Telephone TWIX or Western Union TELEX machines. One simply turns the power on and dials the proper number as one would dial any telephone or teletype station - area code 3 digits, exchange 3 digits, station number 4 digits. When contact with the computer is made the characteristic dial tone is heard. There follows a log-in procedure involving a password. This is in the nature of a library card which identifies the caller as a legitimate user of the system. If a free line is available the user will be so informed and he may then procede to use the computer in any of the capacities that it can function. If the library function is desired one

types TIP. This instruction makes the computer receptive to the library language developed for this purpose. The simplest form of engagement may be initiated by specifying three commands:

SEARCH: defines what literature is to be searched.

FIND: states the items to be found.

OUTPUT: defines the nature and content of the computer output.

The SEARCH command may have the following elaborations:

SEARCH: ALL -will search the entire literature in store.

SEARCH: ALL NEW -will search the last volume of each journal.

SEARCH: PHYREV ALL -will search everything in store of a given journal (in this case the Physical Review).

SEARCH: PHYREV v.120 to v.135

SEARCH: PHYREV v.120

The program will search as specified above and detect any item described under the FIND command which itself has a variety of possibilities.

FIND: AUTHOR = SMITH -will find all papers that include Smith among its authors.

FIND: TITLE = CRYOGENICS -will find all papers that contain the word "cryogenics" in the title.

One may similarly define a location

FIND: LOCATION = M.I.T.

or a citation

FIND: CITATION = 1 131 1165 -will find all papers that cite the article in Physical Review (code 1) volume 131, page 1165

The OUTPUT command selects one or more of the various options available for output. One may call for immediate PRINT, or one may wish a preliminary COUNT of the items found before asking for PRINT. One may also STORE the results under a file name and call for it later for further manipulation if immediate response is not required.

The above commands may be given in any order and any combination. Since the bulk of the computer time involved is spent on reading the material, it is frequently convenient to combine many requests and FIND them all in one SEARCH of the literature. Figure 3 shows one such example. Note that two words A & B typed on one line under FIND are interpreted as A AND B while two words on two lines are interpreted as A OR B. Thus

FIND: SMITH JONES

means find papers by Smith and Jones

FIND: SMITH

FIND: JONES

means find papers by Smith or Jones. Similarly for words in the title and other items.

Several programs have been developed that carry the process beyond the simple SEARCH - FIND function. One such program is the creation of a citation index. The procedure is shown in Figure 4. A by-product of this operation is the citation inventory of a journal, namely the distribution of citations among the various journals. Note that the citations to any given paper or group of

FIGURE 3

COMPUTER RESPONSE TO MULTIPLE QUERY

NOTE: Lower case letters are instructions from the user.
Upper case letters are computer response.

```
tip
W 1050.9

search phyrev volume 133
find
title= multimode cavities
author= garbacz robert j.
location= valparaiso university
citation= 110 109 345
output
print title author location citation
go


PHYSICAL REVIEW
VOLUME: 133
PAGE: 0014
BISTATIC SCATTERING FROM A CLASS OF LOSSY DIELECTRIC SPHERES
WITH SURFACE IMPEDANCE BOUNDARY CONDITIONS
   GARBACZ ROBERT J.
      COLUMBUS, OHIO
      THE OHIO STATE UNIVERSITY
      DEPARTMENT OF ELECTRICAL ENGINEERING

PAGE: 0069
GREEN'S FUNCTION THEORY OF MULTIMODE CAVITIES
   KEMENY G.
      LEXINGTON, MASSACHUSETTS
      KENNECOTT COPPER CORPORATION
      LEDGEMONT LABORATORY

PAGE: 0165
DEUTERON INTRABOND MOTION AND FERROELECTRICITY IN KD2PO4
   SILSBEE HENRY B.
   UEHLING EDWIN A.
      SEATTLE, WASHINGTON
      UNIVERSITY OF WASHINGTON
   SCHMIDT V. HUGO
      VALPARAISO, INDIANA
      VALPARAISO UNIVERSITY

PAGE: 0253
THERMAL CONDUCTIVITY AND PHONON SCATTERING BY MAGNETIC
IMPURITIES IN CDTE
   SLACK GLEN A.
   GALGINAITIS S.
      SCHENECTADY, NEW YORK
      GENERAL ELECTRIC RESEARCH LABORATORY
         J0110  V109  P0345

SEARCH COMPLETED
```

FIGURE 4a

INVENTORY OF CITATIONS IN ANNALS OF PHYSICS (384) v. 28

Index annphy 28

YOUR CITATION INDEX HAS BEEN CREATED
TOTAL NUMBER OF REFERENCES IS 336

count all

COMPLETE COUNT OF CITATIONS FOLLOWS

NREFS	JCODE	JOURNAL NAME
90	1	PHYS REV
22	2	BOOKS
1	4	ASTROPHYS J
2	5	ANN PHYS
5	12	J CHEM PHYS
3	13	J PHYS(USSR)
32	17	NUOVO CIMENTO
1	22	PROC CAMB PHIL SOC
8	23	PROC ROY SOC(LONDON)
24	27	PRIVATE COMM.UNPUBLISHED, TO BE PUBLISHED
2	28	PHIL MAG
4	29	PROGR OF THEORET PHYS (JAPAN)
4	30	REVS MOD PHYS
8	32	REPORTS,TECHNICAL MEMOS
1	33	THESES
8	34	Z PHYSIK
14	41	PHYS REV LETTERS
1	43	HELV PHYS ACTA
5	46	BULL AM PHYS SOC
3	49	PHYS LETTERS
1	51	Z NATUR FORSCH
2	56	ANN REV NUCLEAR SCI
2	74	AM J PHYS
1	76	REPTS PROGR IN PHYS
1	80	J PHYS SOC (JAPAN)
2	96	COMPT REND
1	98	PHYS TODAY
1	120	ZHUR FIZ KHIM (ZHFK, ZFKH)
2	182	PROC THEORET PHYS SUPPL
1	206	ZHUR EKSPTL I TEORET FIZ (JETP)
12	227	J MATH PHYS
22	384	ANN PHYS (N.Y.)
23	669	SOVIET PHYS-JETP
14	682	NUCLEAR PHYS
1	718	CONFERENCE, MEETINGS, SEMINARS
3	730	SOVIET PHYSIC DOKLADY
7	799	PHYS FLUIDS

FIGURE 4b

LISTING OF CITATIONS TO NUOVO CIMENTO (17)
IN ANNALS OF PHYSICS (384) v. 28

print 17
CITATION INDEX FOR--
NUOVO CIMENTO

CITED ARTICLE			CITING ARTICLE		
J0017	V002	P0425	J0384	V028	P0466
J0017	V004	P0323	J0384	V028	P0034
J0017	V007	P0607	J0384	V028	P0060
J0017	V007	P0794	J0384	V028	P0400
J0017	V007	P0843	J0384	V028	P0400
J0017	V008	P0316	J0384	V028	P0466
J0017	V011	P0342	J0384	V028	P0466
J0017	V014	P0951	J0384	V028	P0320
J0017	V017	P0956	J0384	V028	P0435
J0017	V018	P0198	J0384	V028	P0034
J0017	V018	P0466	J0384	V028	P0466
J0017	V018	P0933	J0384	V028	P0034
J0017	V018	P0947	J0384	V028	P0320
J0017	V021	P0186	J0384	V028	P0034
J0017	V021	P0524	J0384	V028	P0466
J0017	V021	P1094	J0384	V028	P0018
J0017	V022	P0362	J0384	V028	P0034
J0017	V022	P0494	J0384	V028	P0034
J0017	V023	P0047	J0384	V028	P0225
J0017	V024	P0870	J0384	V028	P0466
J0017	V025	P0224	J0384	V028	P0466
J0017	V025	P1135	J0384	V028	P0466
J0017	V026	P1254	J0384	V028	P0034
J0017	V027	P0193	J0384	V028	P0034
J0017	V027	P0384	J0384	V028	P0034
J0017	V028	P1294	J0384	V028	P0034
J0017	V028	P1464	J0384	V028	P0034
J0017	V030	P0177	J0384	V028	P0320
J0017	V030	P0450	J0384	V028	P0466
J0017	V030	P1127	J0384	V028	P0320
J0017	V030	P1148	J0384	V028	P0320
J0017	V030	P1512	J0384	V028	P0466

END OF PRINT REQUEST

papers may be obtained with the FIND command as previously described. The present program is a more wholesale listing that generates the entire citation index of a body of literature volume by volume. If the output command is STORE, the indexes of the various volumes can subsequently be cumulated and merged. It is also possible to obtain a citation index to a single journal, or to a single volume of a given journal.

A set of programs has been developed under the general name of SHARE. In this process we name an article and ask that other articles be found that share some element with it. One may ask for Author, Word, Location, or Citation share. The latter is perhaps the most useful example of this class of programs and has been thoroughly investigated by us under the name of bibliographic coupling.[4,5,6,] Figure 5 gives an example of share citation. This example illustrates a combined search of title word followed by a citation coupling. Volume 18 of Soviet Physics-JETP was searched for articles with the word MOSSBAUER in the title. Two such articles were found, p.945 and p.1139. We then search Physical Review v.131 to v.134 for all articles that share citations with the first MOSSBAUER paper in JETP.* For output we requested the title, authors and the shared

---

* The title of this paper is "The Mossbauer Effect on Sn119 Nuclei in a Vanadium Matrix."

FIGURE 5

EXAMPLE OF BIBLIOGRAPHIC COUPLING

```
search phyrev v.131 to v.134
find shared bibliography spjetp v.18 p.945
output print title citations
go


PHYSICAL REVIEW
VOLUME: 131
PAGE: 0529
TEMPERATURE DEPENDENCE AND ANISOTROPY IN THE DEBYE-WALLER FACTOR
FOR WHITE TIN
         J0730  V006  P0881

PAGE: 0535
LOCALIZED MODE DETECTION BY MEANS OF THE MOSSBAUER EFFECT
         J0001  V129  P0028

PAGE: 1008
DYNAMICAL MOTION AND GAMMA-RAY CROSS SECTION OF AN IMPURITY NUCLEUS
IN A CRYSTAL. I. ISOLATED IMPURITIES IN GERMANIUM AND ALUMINUM
         J0001  V126  P2059    J0001  V129  P0028

PAGE: 1500
PHONON SCATTERING BY LATTICE DEFECTS
         J0001  V129  P0028

VOLUME: 132
VOLUME: 133
PAGE: 1062
NUCLEAR ZEEMAN EFFECT IN GOLD ATOMS DISSOLVED IN IRON, COBALT,
AND NICKEL
         J0001  V123  P0816

PAGE: 1553
MOSSBAUER EFFECT FOR FE57 IN BERYLLIUM, COPPER, TUNGSTEN, AND
PLATINUM
         J0669  V015  P0182    J0669  V017  P0195    J0001  V126  P2059
         J0001  V129  P0028

VOLUME: 134
PAGE: 0716
LATTICE DYNAMICAL STUDIES USING ABSOLUTE MEASUREMENTS OF THE
LAMB-MOSSBAUER RECOIL-FREE FRACTIONS
         J0001  V129  P0028    J0001  V126  P2059    J0669  V017  P0195

PAGE: 0965
LOCALIZED MODE IN AN ANHARMONIC CRYSTAL
         J0669  V015  P0182    J0669  V017  P0195    J0001  V129  P0028

PAGE: 1486
FREQUENCY SPECTRA OF BODY-CENTERED CUBIC LATTICES
         J0030  V030  P0250    J0001  V109  P1046
```

citation. Nine articles were found. Although the match here is made on the basis of bibliographic coupling the remarkably close relation between the title of the test paper and those of the retrieved papers is very clear. The relation goes much beyond the mere sharing of words. Of the nine papers, three contain the word MOSSBAUER in the title, four relate to studies on metals, and four deal with metalic crystal structure, lattice and lattice defects. All of these topics are implied in the title of the original paper.

The above examples involve an immediate response from the computer to the user. This may not always be necessary. It is possible to create "standing orders" that will be fulfilled at some slack time when the computer is free from immediate demands, usually late at night. The output instructions may call for a PRINT, STORE, CARD PUNCH or TAPE. An example of this type of operation is the NIGHT LETTER. In this program a stated literature range is to be searched. Whenever a reference is found to a prepared list of papers, a letter is printed, addressed to the author of the cited paper telling him the journal, volume, page, title, author, and location of the paper that cites him. The computer print out is thus the completed message addressed and ready for mailing.

In Figure 6 we show a sample of such a letter produced by searching a recent volume of Soviet Physics-JETP for references to a list of papers that were published by

FIGURE 6

THE "NIGHT LETTER" - See text page 19

TECHNICAL INFORMATION PROJECT
ROOM 14S-312, THE LIBRARIES
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, MASSACHUSETTS

LAX BENJAMIN
RM NW14-3220
NATIONAL MAGNET LABORATORY

*** A MAC TIP ***

INTER-DEPARTMENTAL

YOUR ARTICLE IN--
PHYSICAL REVIEW LETTERS
VOLUME: 003
PAGE: 0217

HAS BEEN CITED IN--
PHYSICAL REVIEW
VOLUME: 133
PAGE: 0280
EFFECT OF SPIN-ORBIT COUPLING AND OTHER CORRECTIONS ON DONOR STATES IN GE AND SI
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M. I. T. Authors in Physical Review Letters.

An interesting possibility is afforded by allowing the computer to interpret instructions in a file previously written and named. For example:

SEARCH: PHYREV v.120 to v.130

FIND: READ FILE SMITH

OUTPUT: PRINT TITLE AUTHORS

In this case instead of specifying what to find the program is directed to read a file called SMITH. This is a file previously prepared by a Mr. Smith who has access to the computer. File SMITH may contain a list of authors, citations, and/or key words that Mr. Smith is particularly interested in. The list (unlike the library proper and the programs) is at Mr. Smith's disposal. He may change it from time to time, add new items, or delete old ones as his needs and experience change. This provides a user with a combined author index, citation index, KWIC and share search tailored to his individual needs.

The ability to derive commands from previously stored instructions applies not only to the FIND operation but to SEARCH as well. An example of that has already been given when we said SEARCH: ALL instead of naming every journal and every volume in store. Another example is SEARCH: NEW LITERATURE. This command has been predetermined to mean SEARCH the latest volume entry of each Journal.

In addition to being a programing, computing and library facility the computer-teletype system is a very effective communication system. This means that the information stored in the computer need not necessarily come from one central source. Every user may also be considered as a source of information communicated to the rest of the system. This is particularly effective when the console user is located in an area of specialized knowledge such as a special information center, a document room or branch library. Such sources may contribute a weekly list of special report aquisitions. These are put in proper format that fits our standard programing language. Any TIP user may then type the request:

SEARCH: ENGINEERING LIBRARY REPORTS

FIND: KEYWORD = CRYONENICS

PRINT: TITLE, AUTHOR, AGENCY, REPORT NUMBER

The search may be made by author, keyword, issuing agency, title word or any other parameter.

Another example of special input is obtained from our central library journals center. This consists of information on the distribution of various journals among the branch libraries. A sample question in this case is:

SEARCH: JOURNAL LIST

FIND: JN. APPLIED PHYSIOLOGY VOLUME 12

PRINT: LOCATION, SHELF NUMBER

The response gives the branch libraries that include .olume 12 of the journal in their holdings and the shelf

number attached to it. It would be relatively easy to extend this facility to a regional level and to include other items of information.

The communication facilities of the system are being used to transmit messages from system to users, and users to system. An example of the former is a daily inventory of literature in store. By typing RESUME LIBRARY the user recieves the latest inventory of available data files. (Figure 7) The user may also recieve a list of programs and ask for a brief description of each program. The latter facility is being elaborated into a teaching program so that a new user may be taught by the computer how to use the computer as a library tool.

The system described above is to be considered as a research tool. It is now being used to investigate a group of problems that range from engineering and cost analysis to the role of human factors in literature search. These and other experiments currently in operation or design will be discussed in part II of this paper.

FIGURE 7

PRINT-OUT OF JOURNALS AND VOLUMES ON DISC STORAGE

NOTE: Directly below each journal title are the alphabetic and numeric codes.

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resume library
W 1211.2


THE JOURNALS AVAILABLE TODAY  11/06/64
ANNALS OF PHYSICS
      ANNPHY   384                VOLUMES   27  TO   29
APPLIED PHYSICS LETTERS
      APPLET   646                VOLUMES    4  TO    5
CANADIAN JOURNAL OF PHYSICS
      PHYCAN    55                VOLUMES   41  TO   42
HELVETICA PHYSICA ACTA
      PHYHEL    43                VOLUMES   36  TO   37
JAPANESE JOURNAL OF APPLIED PHYSICS
      PHAPJA   612                VOLUMES    2  TO    3
JOURNAL OF APPLIED PHYSICS
      PHYAPP    11                VOLUMES   34  TO   35
JOURNAL OF CHEMICAL PHYSICS
      JCHEPH    12                VOLUMES   28  TO   40
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN
      PHYSOJ    80                VOLUMES   18  TO   19
NUCLEAR PHYSICS
      NUCPHY   682                VOLUMES   50  TO   56
NUOVO CIMENTO
      NUOCIM    17                VOLUMES   27  TO   33
PHYSICA
      HYSICA    21                VOLUMES   29  TO   30
PHYSICAL REVIEW
      PHYREV     1                VOLUMES  113  TO  135
PHYSICAL REVIEW, SERIES B
      PHYREB   199                VOLUMES  133  TO  135
PHYSICAL REVIEW LETTERS
      PHYRET    41                VOLUMES    1  TO   12
PHYSICS LETTERS
      PHYLET    49                VOLUMES    3  TO   11
PROCEEDINGS OF THE PHYSICAL SOCIETY (LONDON)
      PHYPRO     2                VOLUMES   81  TO   84
PROGRESS OF THEORETICAL PHYSICS (KYOTO)
      PROPHJ    29                VOLUMES   29  TO   31
SOVEIT PHYSICS - JETP
      SPJETP   669                VOLUME    18
SOVIET PHYSICS - SOLID STATE
      SPSOLS   310                VOLUMES    5  TO    6
SOVIET PHYSICS - TECHNICAL PHYSICS
      SPTPHY   790                VOLUMES    8  TO    9
THE PHYSICS OF FLUIDS
      PHYFLU   779                VOLUMES    6  TO    7
R 3.366+.500
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